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A Final Report
NASA Grant No. NAG-1-46

March 1, 1980 - September 30, 1991

*NUMERICAL ALGORITHMS FOR FINITE
ELEMENT COMPUTATIONS ON ARRAYS
OF MICROPROCESSORS*

Submitted to:

National Aeronautics and Space Administration
Langley Research Center
Hampton, VA 23665-2552

Attention:

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SDYD M/S 240

Submitted by:

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DEPARTMENT OF COMPUTER SCIENCE

SCHOOL OF

ENGINEERING 
& APPLIED SCIENCE

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This is a final report on NASA Grant NAG-1-46.

The thrust of the work under this grant has been to develop algorithms for the solution of structures and related problems on parallel and high performance computers.

This work has led to the following publications.

- L. Adams and J. Ortega, "A Multicolor SOR Method for Parallel Computation," *Proc. International Conference on Parallel Processing*, 1982, pp. 53-56.
- E. Poole and J. Ortega, "An Incomplete Choleski Conjugate Gradient Algorithm for the CYBER 203/205" *Supercomputer Applications*, (R. Numrich, ed.), Plenum Press, 1985, pp. 19-28.
- J. Ortega and R. Voigt, "Solution of Partial Differential Equations on Vector and Parallel Computers," *SIAM Review*, 27, 1985, pp. 149-240.
- C. Vaughan and J. Ortega, "SSOR Preconditioned Conjugate Gradient on a Hypercube," *Hypercube Multiprocessors*, 1987, (M. Heath, Ed.), SIAM, Philadelphia, pp. 692-705.
- E. Poole and J. Ortega, "Multicolor ICCG Methods for Vector Computers" *SIAM J. Numer. Anal.*, 6, 1987, pp. 1394-1418.
- J. Ortega and R. Voigt, "A Bibliography on Parallel and Vector Numerical Algorithms." ICASE Report I-3, 1987, 123 pages. Reprinted in *Parallel Algorithms for Matrix Computations*, SIAM, 1990.
- C. Romine and J. Ortega, "Parallel Solution of Triangular Systems of Equations," *Parallel Computing*, 6, 1988, pp. 109-114.
- J. Ortega, "The ijk Forms of Factorization Methods I. Vector Computers," *Parallel Computing*, 7, 1988, pp. 135-147.
- J. Ortega and C. Romine, "The ijk Forms of Factorization Methods II. Parallel Computers," *Parallel Computing*, 7, 1988, pp. 149-162.
- O. Storaasli, E. Poole, A. Cleary, J. Ortega, and C. Vaughan "Solution of Structural Analysis Problems on a Parallel Computer," Proceedings of the 29th AIAA Structures, Structural Dynamics and Materials Conference, 1988, pp. 596-605.
- B. Mattingly, C. Meyer and J. Ortega, "Orthogonal Reduction on Vector Computers," *SIAM J. Sci. Stat. Comp.*, 10, 1989, pp. 372-381.
- S. Eisenstat, J. Ortega and C. Vaughan, "Efficient Polynomial Preconditioning for the Conjugate Gradient Method," *SIAM J. Sci. Stat. Comp.*, 11, 1990, pp. 859-872.

More detailed descriptions of the above research were given in the semi-annual reports provided to NASA-Langley and also to the National Technical Information Service. Much of the above research was also incorporated in the book

J. Ortega, *"Introduction to Parallel and Vector Solutions of Linear Systems,"* Plenum Press, 1988.

In addition, Professor Ortega directed the work of several graduate students who worked on the subject matter of this grant. These students were supported either by this grant or by NASA Grant NAG-1-242 (a Grad-Aero grant for graduate student support). The following students received Ph.D. degrees in Applied Mathematics with theses as indicated.

Loyce Adams, 1983, Iterative Algorithms for Large Sparse Linear Systems on Parallel Computers.

Charles Romine, 1986, Factorization Methods for the Parallel Solution of Linear Systems.

Eugene Poole, 1986, Multicolor Incomplete Cholesky Conjugate Gradient Methods for Vector Computers.

Courtenay Vaughan, 1988, The SSOR Preconditioned Conjugate Method on Parallel Computers.

Andrew Cleary, 1989, The Parallel Solution of Narrow-Banded Systems.

Two other students, Brett Averick and David Harrar, worked on the topics of this grant in the early stages of their research but finished Ph.D.'s with research in other areas.

The following students obtained masters degrees in Applied Mathematics and are currently completing their Ph.D. degrees:

Lois Curfman
Michael DeLong

The following students completed masters degrees in Applied Mathematics and then left the University:

Andrea Overman, 1988
Clifton Morrow, 1989

Ms. Overman is now employed at NASA-Langley.

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